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A COMPARATIVE EVALUATION OF MECHANICAL SUTURING
OF THE BRONCHIAL STUMP WITH THE UKB-25 AND UKL-60
APPARATUSES IN EXPERIMENTAL PNEUMONECTOMIES

- USSR -

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FOREWORD

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A COMPARATIVE EVALUATION OF MECHANICAL SUTURING
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Following is a translation of an article by F. A. Malafeyev in the Russian-language periodical Grudnaya khirurgiya (Thoracic Surgery), Moscow, Vol. 2, No. 3, May-June 1960, pages 49-51.

A great deal of clinical and experimental investigation was carried out in connection with the problem of the suturing of the bronchial stump. The collective of the workers of the Scientific Research Institute of Experimental Surgical Apparatuses and Instruments proposed a mechanical method of suturing the bronchial stump with tantalum fasteners with the help of the UKB-25 apparatus (P. I. Androsov, L. A. Potekhina, Ye. D. Savchenko, A. A. Strekopytov, and S. A. Sheynberg, 1955).

The mechanical method of suturing in the case of pulmonary resection merits considerable attention. T. N. Shcherbakova (1955) experimentally was the first to prove the possibility of the application of a mechanical suture to the entire radix pulmonis in pneumonectomies with the help of the BS-1-00 apparatus which was designed at the Scientific Research Institute of Experimental Surgical Apparatuses and Instruments. The apparatuses UKL-60 and UKL-40 for the suturing of the entire radix pulmonis or a part of it with a double row of tantalum fasteners were designed at this institute in 1957. The first reports (1958-1959) on the results of the clinical application of these apparatuses (N. M. Amasov, K. K. Berezovskiy, G. S. Zabroda, N. M. Svetozarov, and Ye. S. Lushnikov) indicated the possibility of the widespread use of these apparatuses in pulmonary surgery when pneumo- and lobectomies are performed and segmentary and sparing resections are required.

In this investigation we have undertaken to carry out a comparative appraisal of the feasibility of the mechanical applications of sutures to the bronchial stump with the help of the apparatuses UKB-25 and UKL-60 in cases of experimental pneumonectomies.

Four methods of suturing the bronchial stump were compared in the course of the process of its healing and forming: 1) suturing of the bronchial stump by using the UKB-25 apparatus; 2) suturing of the entire radix pulmonis with the help of the UKL-60 apparatus; 3) suturing of the bronchial stump with single mattress silk sutures (Rienhoff method); 4) suturing with single knotted silk sutures (Sweet method).

We conducted 85 experiments on healthy grown dogs. Sinistral pneumonectomies were carried out on all the dogs. The animals were kept in similar conditions before and after the surgery; no medicines were administered. The animals of the first series were under observation from one day to five months; of the second series -- up to a year. The bronchial stump and the residual pleural cavity were thoroughly examined in all the killed and perished animals. Pathoanatomical and microscopic investigations, rupture tests of the stump by the pneumocolon method were conducted, and the length of the bronchial stump was measured. In addition, the blood supply to the stump in both series was studied by the infusion of the bronchial arteries with the Roentgenocontrast mixture "Gaukh" mass by the A. S. Zolotukhin method (1934) through the thoracic aorta, or with a suspension of lead pigments in turpentine after they are being thoroughly broken down in a mortar to a consistency of thick milk, and the subsequent roentgenovasography of the prepared bronchial stump and the remaining right lung. The operations were carried out under anesthesia; before the operations the animals were administered one milliliter of one percent morphine hydrochloride per five kilograms of body weight.

The thoracic cavity was opened by a left side resection in the sixth intercostal area. After anesthetizing the pulmonary radix pulmonis, and the vagus and sympathetic nerves with a one percent solution of novocaine, the processing of the elements of the radix pulmonis was carried out; the processing differed for each of the series.

The first series comprised 25 experiments. After tying the vessels, the stitchers of UKB-25 were placed on the bronchus, the suturing was completed, and the lung was removed. The stump was tested for hermeticity by means of excessive inflation of the remaining lung; the stump was dusted with 100,000 international units of penicillin; it was then covered by pleura. The pleura was used in 13 of the experiments, while in 12 of the experiments the stump was not covered by pleura. After the completion of the suture, in one of the experiments air infiltrated in the upper corner of the sutured stump. This required the placing of another silk suture. The defect we can explain as being the result of inadequate technique. In the remainder of the experiments the stump was hermetically sutured and the apparatus performed without fault.

One animal of the 25 which had undergone surgery, died on the 14th day from empyema of the pleura and a thoracopleural fistula; in this case the bronchial stump was hermetically sutured and withstood a pressure of 200 mm; the opposite walls of the stump were closely brought together by the tantalum fasteners. In the animals which were examined earlier (to 10 days) hyperemia, hemorrhage, and infiltration were noted in the stump area. The tantalum fasteners firmly brought together the walls of the stump, firmly fixing it on a cartilage foundation, and did not fall out even at a later date. For a period of 1 to 15 days the stump withstood a pressure of 70 to 100 millimeters, three weeks after and later -- 200 millimeters; with longer time the strength of the stump increased.

Microscopical examinations carried out at an earlier time (five to seven days) disclosed an inflammatory reaction, hemorrhage, connective tissue lacertus between the resected walls of the stump, and tissues infiltrated by lymphoid and epithelioid cells. The epithelium was not as yet fully restored at the point of accretion. By the 7th to the 10th day, the point of accretion was well expressed; accumulations of lymphoid and epithelioid cells at the terminal point of the stump were visible; nondifferential microcellular elements entered the lumen of the stump. Two to three weeks later the inflammatory reaction was not expressed, the place of accretion was covered by epithelium, and the tantalum fasteners became encircled by fibroblasts and fibrous tissue.

A month later the accretion of the walls of the stump was well expressed. No necrosis or supuration was noted in any of the 24 experiments. Smoother healing was noted in cases in which the stump was covered by pleura.

The second series (the application of UKL-60 to the entire pulmonary radix pulmonis) included 35 experiments. Following the exposure of the pulmonary radix pulmonis, the stitchers of the apparatus were placed on the radix pulmonis as close to the bifurcation as possible, the radix pulmonis of the lung was sutured, a rigid clamp was placed on the part to be removed, the pulmonary radix pulmonis was intersected at the level of the stitchers, and the lung was removed. The hermeticity was then checked and the stump was dusted with penicillin. Fifteen experiments in which the stump was covered with pleura were carried out; no pleura was used in the remainder of the experiments.

Of the 35 animals which were subjected to pneumonectomy, three died from a bronchial fistula on the 9th, 14th and 20th days; in the last two animals the fistula was combined with empyema of the pleural cavity. In addition, two animals developed an expressed necrosis of the stump.

Nonhormeticity of the stump after its suturing was noted; three of the animals suffered hemorrhages (strong from the lower

pulmonary vein, and slight -- from the bronchial arteries); this could have been due to the unequal clamping of the tissues by the stitchers of the apparatus.

When treated with the UKL-60 apparatus a coarse stump was formed and its infiltration took place earlier and with greater intensity than in those treated similarly in the first series of the experiments. Smoother healing was observed in experiments in which pleura was used to cover the stump. No dropout of the fasteners into the lumen of the stump occurred, and the fasteners firmly were fixed in the sutured tissues. The bronchial stump was considerably longer than that treated with apparatus UKB-25. The average length of the stump treated with apparatus UKB-25 was 1.4 centimeters, when treated with apparatus UKL-60 2.4 centimeters, the Rienhoff method -- two centimeters, and the Sweet method -- 1.5 centimeters.

The infusion of the vessels was carried out in 14 of the experiments (seven each in the first and second series). In processing the radix pulmonis with the apparatus UKL-60 (transverse disposition of the fasteners), the vessels which were distal to the fasteners were inadequately presented on the vasograms; in other experiments they were pervious throughout the entire expanse.

Within seven days clear vasograms were obtained from both series, making possible the determination of the adequate blood supply to the stump.

In the third series of experiments in which suturing was carried out with single and mattress silk sutures with subsequent covering by pleura, one of the animals of 12 died on the second day from emphysema of the mediastinum caused by the insufficiency of the bronchial stump; two of the animals died from bronchopleural fistulas on the sixth and 83rd days after the operation; the fourth animal died shortly after the operation as a result of asphyxia caused by an overdose of the anesthetic. Air infiltration was noted in seven of the 12 animals on which mattress sutures were used. Additional sutures were made in order to hermetically close the stump.

Expressed infiltration of tissues in the area of the stump was noted in the early as well as the later stages; microabscesses were discovered in four of the experiments. A coarse stump of an irregular form with its internal surface ulcerated was formed; at the bottom of the stump were silk threads saturated with pus and either free or tied to the wall of the bronchus. The epithelium frequently had an irregular structure, and in the area of the silk threads there was expressed leukocyte infiltration; necrotic sections were also observed. In the fourth series (13 experiments) the bronchial stump was sutured with single silk sutures by the Sweet method with subsequent coverage by pleura. In three of the

experiments, additional sutures instead of needle centesis to prevent the infiltration of air and obtain hermeticity were made. Five of the 13 animals died after the operation; four -- from bronchopleural fistulas, and one within 1.5 months from thoracopleural fistula and empyema of the pleura. Bronchopleural fistulas developed in one animal on the 3rd day, in the second -- on the seventh day, and in two others -- on the 11th day after the operation. An expressed inflammatory process developed around the silk sutures; this together with defects of the method used may be considered as an important reason for the development of bronchial fistulas. No microabscesses were noted in this series of experiments. The average length of the stump was 1.5 centimeters.

The best results were obtained by us when we processed the bronchial stump with the apparatus UKB-25.

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